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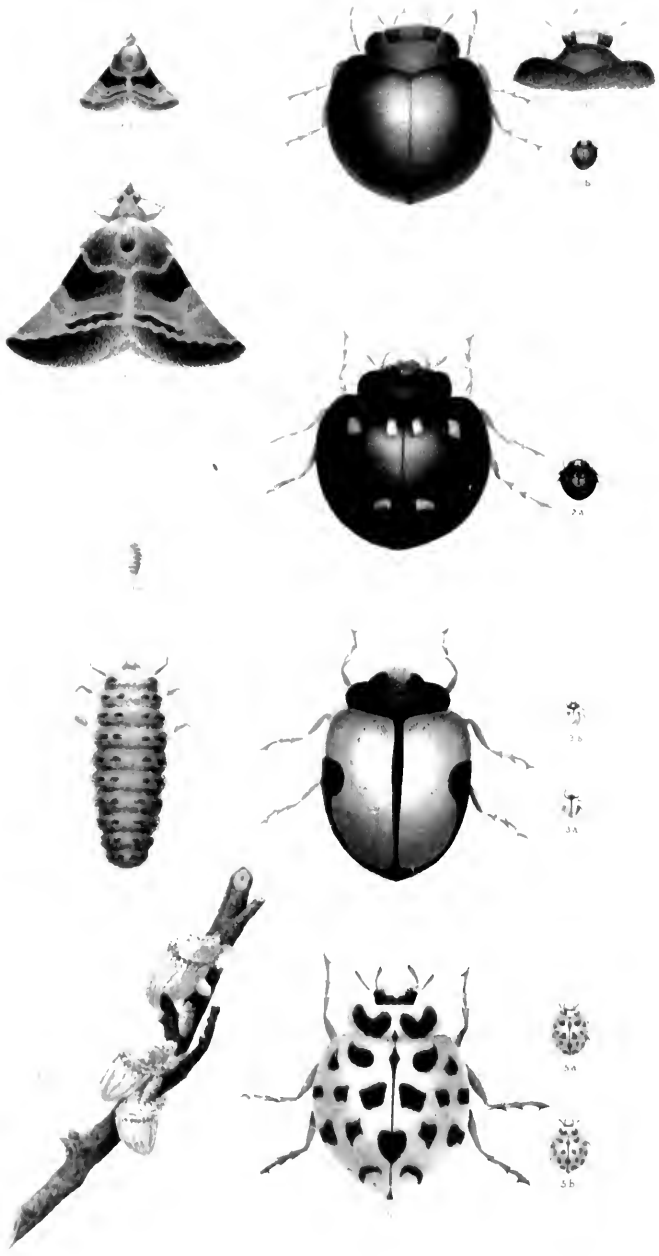
IMPORTATION OF PARASITES

REPORT

OF

State Board of Horticulture

1892



NEWLY INTRODUCED SPECIES.

H. S. CROCKER COMPANY LITH. S. F.

BENEFICIAL INSECTS.

SPECIES OF RECENT INTRODUCTION.

[Explanation of Plate.]

1. *Orcus chalybeus*, Boisd.; female enlarged.
1*a*. Head and prothorax of male; enlarged.
1*b*. Natural size.
2. *Orcus australasia*, Boisd.; female enlarged.
2*a*. Natural size.
3. *Novius Koebelei*, Olliff.; male enlarged.
3*a*. Male; natural size.
3*b*. Female; natural size.
3*c*. Larva; enlarged.
3*d*. Larva; natural size.
4. Shows branch with Cottony Cushion Scale, and larva of *Novius Koebelei*.
4*a*. Cottony Cushion Scale.
4*b*. Shows larva of *Novius Koebelei* (natural size), preying upon Cottony Cushion Scale.
5. *Leis conformis*, Boisd.; female enlarged.
5*a*. Male; natural size.
5*b*. Female; natural size.
6. *Thalpochares coccophagus*, Myer; enlarged.
6*a*. Natural size.

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REPORT

ON THE

IMPORTATION OF PARASITES

AND

PREDACEOUS INSECTS,

BY THE

STATE BOARD OF HORTICULTURE.

Albert Koebele

IN ACCORDANCE WITH AN ACT OF THE LEGISLATURE, APPROVED MARCH 31, 1891.

183639

SACRAMENTO:
STATE OFFICE, : : : : : A. J. JOHNSTON, SUPT. STATE PRINTING.
1892.

REPORT.

To Hon. H. H. MARKHAM, *Governor, and to the honorable the Legislature of California:*

In accordance with an Act (Chapter CXCIV, Laws of 1891) entitled "An Act to appropriate $5,000 for the purpose of sending an expert to Australia, New Zealand, and adjacent countries, to collect and import into this State parasites and predaceous insects," approved March 31, 1891, we beg to submit the following report:

Soon after the passage of this Act we applied to the Secretary of Agriculture at Washington, D. C., to aid us in this investigation by sending on this mission Mr. Albert Koebele, an accredited agent of that department, and who, on a former mission, discovered the *Vedalia cardinalis*. We also requested that his salary be met by that department, we assuming to pay his expenses. This the Secretary consented to do, and on August 20, 1891, Mr. Koebele sailed for Australia, where he remained about a year. As to what was accomplished, we beg to refer you to his report and to the report of the Entomologist of this Board, which are herewith appended.

AMOUNT EXPENDED.

The following are the expenditures incurred; all vouchers and itemized bills are on file in the office of the State Controller:

1891—Oct. 31—Voucher No. 1	$395 25
Oct. 31—Voucher No. 2	380 68
Nov. 30—Voucher No. 3	313 43
Dec. 28—Voucher No. 4	236 87
1892—Jan. 25—Voucher No. 5	297 54
Feb. 29—Voucher No. 6	312 00
Mar. 21—Voucher No. 7	297 47
Apr. 25—Voucher No. 8	365 52
Aug. 4—Voucher No. 9	918 12
Sept. 26—Voucher No. 10	131 65
Cost of transmitting funds—	
Voucher No. 11	24 75
Voucher No. 12	10 00
Voucher No. 13	15 00
Voucher No. 14	13 90
Cost of illustrating report—Voucher No. 15	625 00
Total	$4,337 18
Balance unexpended	662 82

This amount has been returned to the State Treasurer, as is shown by certificate from Controller's office, No. 163.

Our thanks are especially due to Hon. J. M. Rusk, Secretary of Agriculture, and to all who rendered us assistance in this research.

Very respectfully,

ELLWOOD COOPER,
L. W. BUCK,
FRANK A. KIMBALL,
J. L. MOSHER,
A. BLOCK,
FRED. C. MILES,
SOL. RUNYON,
I. H. THOMAS,
A. F. WHITE,
Commissioners.

B. M. LELONG,
Secretary and Chief Horticultural Officer.

SAN FRANCISCO, CAL., December 5, 1892.

EXPERT'S TRIP TO FOREIGN COUNTRIES.

NEW SPECIES INTRODUCED.

To Hon. ELLWOOD COOPER, *President, and to the honorable State Board of Horticulture:*

SIR: At your request I give herewith some notes on the condition of fruit trees and the coccids injurious thereto in Australia, also the work of natural parasites upon the same in that country, as found during my recent mission; at the same time giving you a statement as to how I found the recently introduced species on my trip to Los Angeles and Santa Barbara at the beginning of September, 1892, and my opinion of their future work in this country.

My report upon this last trip has been forwarded to the Secretary of Agriculture, to whom I had to report as directed in letter of authorization, dated May 29, 1891. In it I give a full account of all the beneficial insects found and forwarded to this country, as also of such as were studied in the field, and which may be introduced at some future time. As this report will not appear in print until some time during 1893, I will briefly acquaint you with what was accomplished.

As you are aware, my chief work was to search for such parasitic and predaceous insects as prey upon the coccids injurious to our fruit trees. These are the so-called red scale (*Aspidiotus aurantii*, Mask.), detrimental to our orange trees; the pernicious scale (*Aspidiotus perniciosus*, Comst.), upon and destructive to various deciduous trees; and the various black scales (*Lecanium*), as the principal species.

The red scale is present all over Australia upon citrus and various other trees and shrubs, and has been known upon orange trees for the last fifty years. Whether the insect is a native or introduced cannot be said with any certainty, but as the conditions indicate, I think it is an introduced species. Internal parasites could rarely be found upon the same; chiefly upon the male scales, small holes were occasionally found, from whence minute chalcid flies had issued. None of these were bred.

The black scales are represented by various species, and our most common forms, *Lecanium oleæ*, Bernard, and *L. hesperidum*, Linn., are found everywhere in New Zealand and Australia, and in my opinion are indigenous to the latter country. Numerous internal parasites were found preying upon these two coccids, and were repeatedly sent here. It is in predaceous insects feeding upon the various coccids that Australia is immensely rich, and these are chiefly ladybirds (*Coccinellidæ*).

The group *Orcus* resembles our own form *Chilocorus*, of which *C. bivulnerus* is well known in California. The habits are the same; they will breed upon a variety of scales from early spring until winter, when the mature insects will hibernate for a time. Four species of these were sent here, and two of them, *O. chalybeus* and *O. australasia*, in very

large numbers. *Cryptolæmus* was found in two forms, *C. Montrouzieri* and *C. australis*. The larvæ of these are peculiar, as they are covered above with contiguous, white, mealy, secreted appendages; they feed chiefly upon mealy bugs (*Dactylopius*). The first named species, which was sent here in large numbers, is also doing good work in feeding upon the various black scales.

Bucolus is closely related to *Cryptolæmus*, and two forms were sent here. Probably the most valuable of all the scale-feeding *Coccinellidæ* are the *Rhizobiids*. This group is very largely represented in Australia, and only a few forms are reported from other parts of the world. America had none previous to this importation. The insects are closely related to our *Scymnids*, but some of the species are much larger. They feed upon all sorts of scales, and their larvæ were found at all times during the year in Australia. Some fifteen species, nearly all unknown to science, were sent here.

Scymnodes also resembles *Rhizobius*; but one species, *S. Koebelei*, Blackburn, and a variety of the same, named *varipes*, were sent here. These are expected to feed upon black scales and *Chionaspids*. *Erithionyx* is quite a large black beetle covered with short, yellowish-brown hairs; the one species, *E. lanosus*, was found feeding on *Chionaspis*, upon orange trees infested with black scale, and was repeatedly sent here. These species were liberated by you upon *Lecanium*.

Scymnus is known to almost every one; we know the value of our *S. marginicollis* in California, and the good work it is able to do upon a variety of scales. I have so far eight species named from Australia and a number from New Zealand, which were sent here. These can be expected to feed upon most of our coccids.

Mydus resembles a *Scymnid*, and *M. pygmæus*, feeding upon mealy bugs, was sent here; and there are a number of groups of small, roundish *Coccinellidæ*, of which *Gymnoscymnus*, *Cycloscymus*, *Libernes*, *Cyreme*, and *Scrangium*, found upon a variety of coccids, were sent here.

As to the aphis-feeding *Coccinellidæ*, all the species that could be obtained were collected and forwarded. Some of these will not only feed upon plant-lice, but will also live upon scale insects. *Coccinella antipodum* has only been found by me to prey upon scales in New Zealand. *Coccinella arcuata* was found in southern Queensland feeding upon the orange aphis, but on the Richmond River, New South Wales, the same insect was feeding upon *Lecanium filicum* on a fern, and again at Levuca, Fiji, it was feeding upon an *Aleurodes* on taro leaves. *Leis conformis*, which feeds on plant-lice, will, after these have all disappeared, begin its destructive work upon the woolly aphis, of which it cleans whole orchards, as observed in South Australia and Victoria.

In all, some forty thousand specimens of ladybirds were collected by me during this last trip, and forwarded to California, and I can say positively that no mistake was made in sending anything but beneficial insects.

It was timely discovered that nearly all the larvæ of the ladybirds in Australia are preyed upon by parasites, in certain instances almost destroying all of these. The pupæ are also preyed upon by chalcid parasites, and in consequence only the mature insects were sent, thus leaving all their enemies behind, and we shall thereby have the benefit of the work of these insects without the detriment of the parasites preying upon them.

One of the best enemies to the black scale in Australia is the larva of a small moth (*Thalpochares*), which builds itself a house, so to speak, by spinning together the remains of the eaten-out scales, etc. With this protection against its enemies, it is able to walk over the tree, and thus devours large numbers of the scales daily. The transformations of this insect have not been closely studied in the field, but from what I have seen must be very rapid, especially in warm weather; and as full-grown larvæ were found upon the same tree about every two weeks, it will take at the most four weeks from egg to mature insect during summer. When full grown the larva spins most anywhere on the tree, but prefers any crevice on branches or trunk of tree, between the forks, and also on the ground at the base of stem. According to the season or circumstances, they may pupate at once or remain for several months, and in no case should they be disturbed in any way, for if taken out of their cocoon they will rarely be able to spin another and will invariably perish. Two species were found in Australia, and one at least is introduced and established.

The trunks and branches of citrus trees in Australia are often covered with fine, silky webs interwoven with remains of scales, and under this are found numerous larvæ of a small *Tineid* moth that devour the coccids thereon. These latter are chiefly *Chionaspis citri* and *Mytilaspis Gloverii*. Efforts are now being made to introduce this valuable little moth here, and a number were liberated upon trees infested with the pernicious scale.

Aside from the numerous parasites and predaceous insects destructive to scale insects in Australia, there exist several species of fungoids detrimental to various coccids. *Microcera coccophilla*, if once started upon a tree infested with the red scale, will keep on spreading until all the scales are destroyed. The same may be said of the fungi living at the expense of the black scales. I have had a number of small orange trees infested with *Lecanium*, on which also were ants that kept away the natural enemies—upon which the *Thalpochares* larvæ were collected regularly, as these with their protecting armor are quite safe here—on some of which the fungus began to spread until every black scale upon the trees was destroyed. The fungus will apparently only grow during damp weather, and I shall try it in the early spring. If once started this could easily be disseminated.

The condition of the olive trees, as observed in South Australia, is fairly good. Some of these are more or less infested with black scale (*Lecanium cassiniæ*, Mask.), but notwithstanding this, trees seen on a hillside, growing wild, so to speak, were loaded with fruit and but few of the trees had scales in quantity. It was at a time when everything was completely dry that I visited South Australia, and the predaceous insects found feeding upon these scales may not be all that prey upon them at other times of the year. The species found in larva, pupa, and imago state upon olive were *Rhizobius hirtellus*, *R. cæcus*, and *Cyreme nigellum*. The first-named species was present in very large numbers, and was found upon various scales in New South Wales, as also other coccids. Both the larvæ and pupæ of the *Rhizobiids* were found destroyed in large numbers by parasites.

In New South Wales, where my work kept me during the time among the orange trees chiefly, the species of *Coccinellids* found preying upon *Lecanium* were far more numerous. I will mention but a few, which

are always present in large numbers with the black scales. These are: *Orcus australasia*, *Rhizobius ventralis*, *R. hirtellus*, *Cryptolæmus Montrouzieri*, and the larva of the *Thalpochares* moth, which alone is able to free whole trees in a very short time. It is only upon bushes or young trees generally covered with large numbers of ants, which prevent the predaceous insects from coming near, that the black scales become numerous. Upon old trees these coccids are but rarely found in numbers, and if so, only upon an occasional branch, which is speedily cleaned again by the numerous predaceous insects preying upon them.

The red scale (*Aspidiotus aurantii*) is, perhaps, aside from *Mytilaspis Gloverii* and *Chionaspis citri*, the most numerous coccid upon citrus trees in Australia, and in fact is at present the most injurious to citrus trees in that country; but its progress is checked by its natural enemies. Australia is in possession of more than enough natural enemies to keep this coccid in check with ease, although nearly all these are preyed upon by parasites. To spray or fumigate to kill the red scale would also mean the destruction of the numerous beneficial insects, and those that were not killed outright would mostly leave the orchard in search of other food, and the consequence would be that in a few months the trees would again become infested, with but few enemies present, and the scales would do great damage unless "the spray is again applied."

As it is, at the present time in Australia, orange and lemon trees are often planted in almost any locality, without regard to the situation, condition of soil, drainage, climate, and other conditions. The consequence is that some of these orchards become diseased, presumably from the effects of the red scale, and, as is the case in the Gorden district, near Sydney, one tree after another will succumb. An examination showed that these trees had been planted in heavy, clayey soil, without any drainage, and were invariably destroyed by the so-called "foot-rot." The fact is, that if an orange or lemon orchard, as the case may be, is left for years without any attention whatever, the weeds allowed to grow, and planted in an unsuitable location or soil, before very long the leaves become yellow and drop off slowly, and in time the remaining green leaves become covered with red scales, since, as is always the case, the predaceous insects preying upon this scale will not be found on such trees, as they prefer those with dense foliage and shade. Such trees may thus linger for months, or even years, before dying, and may even again recover if proper attention is given them. In one of such orchards, of several acres in extent, but a few living twigs covered with red scale were found, yet not a single one of the many predaceous insects preying upon them could be noticed. In another instance, an orchard of some eight or ten acres and about thirty-five years old, the proprietor of which always supplied sufficient manure and kept the ground cultivated, during the whole time of its existence had been infested with red as well as other scales, and yet but a very few trees along the border of one side could be found that showed any traces of such. The whole orchard during the thirty-five years had never been pruned or sprayed, nor even had the trunks ever been washed. Numerous dead limbs were present, the stems and limbs partly covered with lichens, and yet I did not meet with a finer lot of trees in Australia—such glossy, deep-green foliage, abundance of fruit, and so free from scale.

A large number of predaceous insects were found preying upon the red scale in Australia. Of the most numerous were *Orcus chalybeus*, *Orcus australasia*, and *Rhizobius satellus*. Aside from these, numerous other species of *Rhizobiids* were found preying upon this scale, and many species of *Scymnids*, all of which were sent here. In my report all of these are treated separately.

On my visit to Los Angeles and Santa Barbara in the beginning of September, *Orcus chalybeus* were found at Los Angeles, where this species was liberated upon the red scale, in such numbers that we can reasonably hope they will have increased by next April, so that we may distribute them throughout many orchards.

The condition in which the insects liberated by you upon the olive scale were found was even better than I had expected. The species present were *Orcus chalybeus*, *O. australasia*, *Rhizobius ventralis*, and *R. debilis*. Without doubt other species sent to and liberated by you will appear in large numbers next spring. It is impossible to find, within a couple of hours' search, all the species present in a large orchard. *Orcus australasia* and *Rhizobius debilis* are feeding upon the pernicious scale (*Aspidiotus perniciosus*) at Alameda, where they were liberated by Mr. Craw, who at the same time left a number of *O. chalybeus* upon these coccids; but these have all disappeared, though, positively, not to die. They will be found upon *Lecanium* or *Chionaspis* in time. I have never found this insect feeding upon *Lecanium* in Australia, and did not expect it would feed upon *L. oleæ* with you; but this will only show that a coccid-feeding ladybird, if at liberty, will most always find its food for future generations, and no doubt most of the species liberated here will be found again in numbers upon some scale.

In regard to the two species of *Orcus* we now possess, they were found, if my observations in the field are correct, to be two-brooded in Australia, the mature insects hibernating during winter. The *Rhizobius* are much faster in breeding, and I estimate about six broods per year. The larvæ of these, although not numerous at the time, were found in midwinter.

These insects here, with but few enemies, should increase about fifty-fold with each brood, and from one female of *Orcus* we should expect about 2,500 beetles at the end of the season, under favorable circumstances; while of *Rhizobius*, with six broods, upward of 15,000,000,000 beetles could be expected, and these figures will not be much out of the way in your orchard, where there is an unlimited supply of food.

On a day when the temperature reached above 100° F. in the shade in Australia, the number of *Orcus chalybeus* upon each orange tree could be estimated, as all the beetles came down on the stems near the ground, which was a beautiful sight for an enthusiastic bug-hunter, and from 175 to 300 beetles were collected on each stem; but the larvæ of the same upon the trees were probably ten times as many. It should be understood that these trees are never sprayed.

Some 1,500 different beneficial ladybirds are known at present in the world, and more than half of these will feed upon scale insects. We should do our best to import as many of these as possible, and at the same time guard against any new importations of coccids.

It is not that we should exterminate our scale insects—this is a matter of impossibility even with the best of natural enemies or parasites, and would be contrary to nature; but we can, with the proper natural

enemies, keep these insects in check to such an extent that they will not injure our trees, and fruit growing will be possible for all time to come.

Respectfully yours,

ALBERT KOEBELE.

ALAMEDA, CAL., November 14, 1892.

REPORT ON CONDITION OF NEWLY INTRODUCED SPECIES IN CALIFORNIA.

To B. M. Lelong, *Esq., Secretary, and to the honorable State Board of Horticulture:*

Sir: In accordance with letter of instructions of August 28th, to proceed with Mr. Albert Koebele to Los Angeles, San Gabriel, Orange, and Santa Barbara Counties, and make an inspection and report upon the condition of the beneficial insects that have been placed there, and which were sent over by Mr. Koebele from Australia during his recent mission to that country, having completed said examination, I beg to herewith submit the following report:

On August 31st, Mr. Albert Koebele and I visited the orange orchard of Albert F. Kercheval, at Los Angeles, where the first colonies of ladybirds from Australia were placed, and which arrived last winter and spring. Besides ourselves there were present John Scott, Horticultural Commissioner of Los Angeles County; D. W. Coquillett, Special Agent of the Department of Agriculture; Henry W. Kruckeberg, editor "Rural Californian;" Col. J. R. Dobbins, A. Scott Chapman, Esq., of San Gabriel, and others.

It was at this place that the beetles of the first shipment were placed. These arrived in very feeble condition. Mr. Koebele says that they probably hibernated in Australia, and possibly had deposited their eggs before he captured them. However, after a careful examination of this place we found beetles, eggs, larvæ, and pupæ of the steel-blue ladybird (*Orcus chalybeus*). Insects of later importations were received in good condition, and upon our visit we found sufficient of their eggs and pupæ to justify the assertion that this species has become established at Los Angeles. Mr. Koebele says this is the insect that keeps the red scale (*Aspidiotus aurantii*) in check in the orange groves in Australia, notwithstanding that a parasite preys on these ladybirds there, which destroys fully 50 per cent of their first brood, and about 90 per cent of the second brood. Great care was taken not to introduce this parasite, which is such a deadly enemy to them. When Mr. Koebele discovered that the young of these ladybirds were preyed upon by a parasite, he sent only mature beetles to California. Thus it may be safely said, that it will only be a matter of time when we shall reasonably hope for the rapid increase of these valuable insects, and even better results from them than are obtained in Australia.

In another orchard at Los Angeles where a colony had been placed, we found but few beetles and larvæ, but enough to show that at this place also they had become established.

On September 1st, Mr. John Scott and Mr. Hiram Hamilton, Horticultural Commissioners of Los Angeles and Orange Counties, respectively, and I examined the orchard at Orange where a colony of the steel-blue ladybirds you sent Mr. Hamilton had been placed. We found

these doing well, and there were plenty of beetles and eggs from which small larvæ were hatching and were at work upon the red scale. These ladybirds had only been out on the trees sixteen days, and as they are breeding there successfully, it is conclusive proof that the earlier importations had already deposited their eggs before they arrived.

On September 2d, Mr. John Scott, Col. J. R. Dobbins, of San Gabriel, Mr. Koebele, and I inspected the Dobbins orchard at San Gabriel, where one of the first colonies of these insects was placed. These, too, arrived in very feeble condition, and in fact, hardly any survived the trip.

A later importation, which you sent Mr. Chapman, arrived in good condition, but as they were liberated on large trees they had no doubt flown over the orchard, where they will appear later on.

On September 3d, Mr. Koebele and I visited Hon. Ellwood Cooper's orchard at Santa Barbara. It was at this place that several species were liberated in the open orchard immediately upon their arrival. We found four species that have become well established, viz.: *Orcus chalybeus*, *Orcus australasia*, *Rhizobius ventralis*, and a small *Scymnodes*. Of all these we found beetles, eggs, larvæ, and pupæ. The trees upon which they were placed are infested with black scale, and they are feeding upon it. Mr. Cooper placed these insects in an orchard where he considered the conditions as to temperature and protection from the prevailing winds favorable for their colonization.

On September 9th, I visited the orchard at Haywards, Alameda County, where Mr. Koebele had himself placed several species. I found beetles of the *Orcus australasia* and *Rhizobius ventralis*, apparently doing well. At this place a muslin tent was placed over a lemon tree where the *Thalpochares coccaphagus*, an enemy to the black scale, is being bred.

I placed a small colony of *Orcus australasia* and *Rhizobius ventralis* upon trees infested with pernicious scale in Alameda, and upon examination two days ago we found beetles, larvæ, and pupæ. The larvæ have fed upon the scale and passed through their molts into well-developed pupæ, proving conclusively that they will prey upon it.

The new Australian ladybird, *Novius Koebelei*, of which only three live insects were received last April, and which were bred in the office, have multiplied very rapidly, and from these many thousands have been distributed. The successful colonization of this ladybird has fully sustained Mr. Koebele in the statement, that they are even better than the *Vedalia cardinalis* in keeping the cottony cushion scale in check. The colony of fifty which you gave Mr. John Scott, of Los Angeles, have done well, and from those he has distributed several thousands, and is well pleased with their work.

From the foregoing it will be seen that five new species of beneficial insects have been successfully introduced and become established in the State, and while we cannot expect much benefit from them this year, as time is required for those introduced to breed, I am confident that next spring and summer they will be abundant, and colonies can then be furnished to growers throughout the State.

The unprecedented success of the *Vedalia cardinalis* has caused fruit growers and others to expect immediate and similar results from all of the new insects, but as the *Orcus chalybeus* and *Orcus australasia* have only three generations, their increase will be slower; however, I feel satisfied that the final result will be equally as satisfactory as with

the *Vedalia*. For the present, orchardists having trees infested with red scale should not neglect spraying or fumigating this fall, so that their fruit will be bright and merchantable, and prevent injury to the trees for the present from the pernicious effects of the pest.

Mr. Koeble has reviewed this report, and concurs in the same.

ALEXANDER CRAW,
Entomologist and Quarantine Officer.

SAN FRANCISCO, CAL., September 10, 1892.

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